Modification of Passive Films on Type304 Stainless Steel by Ultra-Violet Light Irradiation in Neutral Chloride Solution

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The photo inhibition of pitting corrosion was firstly reported by Macdonald *et al.* [1] for pure Ni in chloride ions containing neutral solution. They also found the photo-inhibition is also applicable to austenitic stainless steels, suggesting modification of passive film by photo irradiation [2]. We have confirmed that pitting corrosion on Type304 stainless steel in neutral chloride solution was suppressed by ultra-violet light irradiation as a result of enhanced Cr enrichment in the passive film [3]. We also reported that the passive film formed on Fe-18Cr alloy was modified to have more enriched Cr content by photo irradiation during the initial stage of passivation in 0.1 mol/l H_2SO_4 solution and discussed that such photo induced effect were highly concerned with the semiconductor property of passive film [4]. In the present work, the modification of passive film on Type304 stainless steel in neutral chloride solution by *uv* light irradiation is characterised by X-ray Photoelectron Spectroscopy (XPS), Electrochemical Impedance Spectroscopy (EIS) and Photo electrochemical .

Type304 stainless steel was exposed to *uv* light generated by He-Cd laser during potentio-static polarisation in 3.5 % NaCl solution at room temperature. XPS analysis was conducted on the specimen after passivation at various passivation potentials with and without *uv* light irradiation to reveal that the Cr content in the passive film was increased by *uv* light irradiation, resulting in improvement of pitting corrosion resistance. Passive films were also formed changing the intensity of *uv* light irradiation. Figure 1 shows that the Cr content in the passive film increases with increasing *uv* light intensity irradiated during passivation. The electronic property which was characterised using photo current and electrochemical capacitance revealed that passive film is regarded as n-type semiconductor with band gap energy of approximately 3.5 eV. The donor density in the space charge layer of the film, which is estimated from the Mott-Schottky plot of capacitance, increased with an increasing light intensity as shown in Fig.2. That is, enhanced Cr enrichment may be correlated with the increased defects which is generated by uv light irradiation. The Cr enrichment in the passive film of stainless steels usually occurs as a selective dissolution of Fe. Therefore, the Cr enrichment is stimulated by enhanced migration of Fe ions in the passive film. The electron-hole pair generated by photo-irradiation may be attributed to the Cr enrichment process. Although a part of electron-hole pair were separated to be consumed by some electrochemical reactions, a large amount of them were re-combined to release energy in various process, including the production of defects in the passive film to provide easy path of migration of Fe ions in the passive film, resulting in the enhanced enrichment.

References

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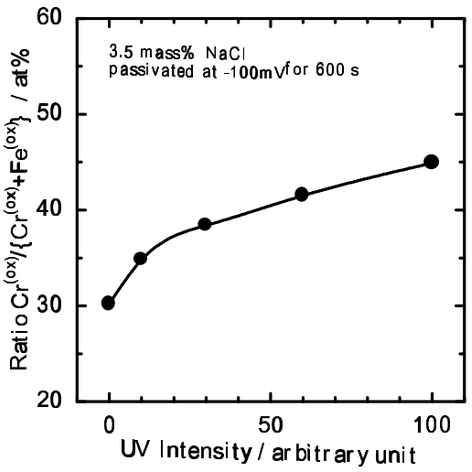

Figure1 Changes in the Cr content in the passive film formed on Type304 stainless steel with *uv* light irradiation of various intensity.

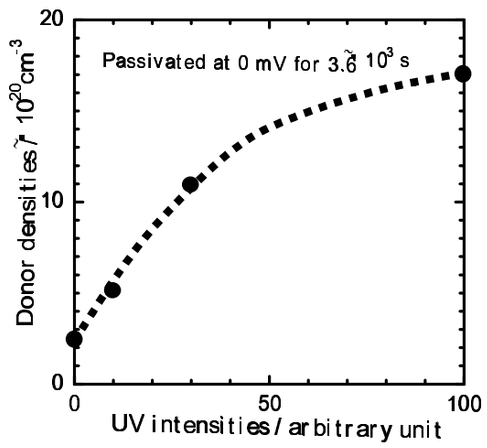

Figure 2 Changes in the donor density in the passive film formed on Type304 stainless steel with *uv* light irradiation of various intensity.